ELECTRIC WATER HEATER INVESTIGATION

Ohio 95 Franklin

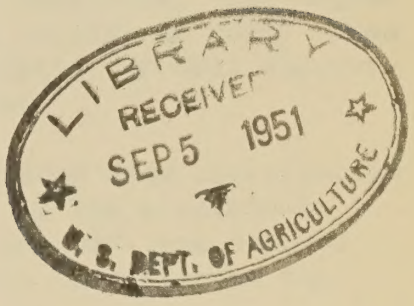
U. S. DEPARTMENT OF AGRICULTURE

RURAL ELECTRIFICATION ADMINISTRATION

ELECTRIC WATER HEATER INVESTIGATION

(Ohio 95 Franklin)

FINAL REPORT



U. S. Department of Agriculture
Rural Electrification Administration
Technical Standards Division
In Cooperation With
Ohio Midland Light And Power Company
Canal Winchester, Ohio

1949

ELECTRIC WATER HEATER INVESTIGATION

OHIO 95 FRANKLIN

Introduction

The benefits of electricity in modern-day farming are obvious to all persons working in the field of agriculture. All REA borrowers are very much interested in assisting their members in making the most effective use of electric power. It behooves all cooperatives to assist their members in the selection of the type and size of electrical equipment that not only meets their needs, but the initial investment and operating cost must be such that the member can afford.

Among the necessary requirements for providing adequate sanitation facilities on the farm the hot water supply is paramount. Electricity offers a reasonable and reliable method of providing hot water. There is no question that electric water heaters are one of the most desirable types of loads to have on distribution systems. It is for this reason that many power suppliers offer a special energy rate to water heater consumers. The degree of saturation of electric water heaters is increasing rapidly in rural areas and the importance of knowing the operating characteristics of this electrical appliance on rural distribution systems is apparent.

The control of certain domestic appliances, to remove them from distribution systems during peak load periods, has been considered by the electrical industry for many years. Investigations have shown that off-peak control is most applicable to equipment which acts as a storage unit such as the water heater.

As a result of power shortages, high demand charges, and overloaded distribution systems. REA financed cooperatives are showing widespread interest in means of reducing peak demands on their systems. Many are considering the purchase and installation of water heater control equipment with the hope of remedying these unsatisfactory operating conditions.

Investigations of the characteristics of water heater loads to determine the adaptability and feasibility of various types of off-peak control equipment are also being conducted by this Division. Before final conclusions can be drawn concerning the advantages and/or disadvantages of such practices to the cooperative and member-owner, basic data such as this study provides are necessary since the effects of the control equipment on the consumer should be given serious consideration.

The system selected for this study was the Ohio Midland Light and Power Company, Canal Winchester, Ohio, of which Mr. J. E. Cathers is the manager. It had separate meters on all water heater installations. Records were available as to the electric energy consumption of all electric water heaters installed since 1934.

Objectives Of The Investigations

The objectives of the electric water heater study were:

1. To determine the electric water heater requirements of rural consumers.
2. To determine the energy consumption of electric water heaters for farm and non-farm domestic consumers by months, seasons and years.
3. To determine the effect on the energy consumption of electric water heaters when supplemental water heating is employed.
4. To collect electric water heater data which will serve as a guide for economic feasibility studies; for rural line construction specifications based upon energy demand and consumption; for setting up rate structures; and other related operating and management problems.
5. To determine the effect of the class of consumer, the size of water heater, number of persons in the household, and other variables on the energy consumption and operating characteristics of electric water heaters.
6. To determine from testimonial data the reactions of rural consumers toward electric water heater service.

Method Of Conduct

A complete analysis was made of the consumer meter records of the 550 electric water heater installations. Of this number a tabular analysis of 495 heaters was conducted. The water heaters analyzed were grouped as follows:

1. 300 water heaters were analyzed for farm and non-farm domestic consumers where each was connected during the full calendar year, 1947. These water heaters were in the following classes:

   166 farm with no supplemental water heating
   42 non-farm domestic with no supplemental water heating
   68 farm with supplemental water heating
   24 non-farm domestic with supplemental water heating

2. 195 water heaters were analyzed for farm and non-farm domestic consumers where the heaters were connected for less than a complete calendar year. These heaters were in the following classes:

   130 farm water heaters with no supplemental means of water heating
   65 non-farm domestic water heaters with no supplemental means of water heating

Questionnaires were mailed during the month of October 1948 to all consumers having electric water heaters. The mail inquiry yielded 67 percent returns. Information was secured from all non-respondents by personal interview during

the month of December 1948. Questionnaires were completed for 490 consumers. The following information was secured:

Class of consumer
Type of farm, if farm
Number of persons in household
Size of heater
Type and number of bath installations
Supplemental water heating, if any
Adequacy of hot water supply
Satisfaction of service

Additional analyses were conducted as to the electric energy consumption of water heaters by grouping them as to the size of tank; by grouping them as to the types of farms on which they are installed; and by grouping them as to the number of persons served per water heater.

For the purpose of simplifying the investigation, water heaters were grouped in sizes of 30, 40, 50, 60 and 80 gallons rather than the NEMA standards of 30, 40, 52, 66 and 80 gallons.

Findings

a. Energy Consumption

From TABLE I it may be seen that the average energy consumption of electric water heaters constituted between 40 and 50 percent of the monthly kwh used by the 495 consumers. Energy consumption of farms, for both water heaters and all uses, was considerably more than for non-farm domestic consumers. The average monthly energy consumption of the water heaters on farms, with no supplemental heating, was 18.2 percent greater than for those on non-farm residences during 1947. Farm consumers who employed supplemental heating in conjunction with electric water heating used more electric energy for all other purposes than did those using no supplemental heating. The former had somewhat larger homes with central heating systems; in many cases had higher incomes; and had a greater number of farm and home electrical appliances.

The average monthly energy consumption of the 300 water heaters connected during the full year of 1947 was 203 kwh per month. Chart No. 1 shows over one-third of the consumers employed supplemental water heating. This had a considerable effect in reducing the average monthly energy consumption of electric water heaters during the winter months. Chart No. 2 gives a graphical picture of the average monthly energy consumption of all farm water heaters for 1947 whereas Chart No. 3 represents like information for all non-farm domestic water heaters for the same year. A graphical comparison of the average monthly energy consumption of all farm and non-farm domestic heaters is shown in Chart No. 4. The average month to month energy consumption for the water heaters was relatively constant.

TABLE I

ANALYSIS OF THE AVERAGE MONTHLY ENERGY CONSUMPTION FOR 495 WATER HEATERS AND FOR ALL USES FOR 1947

Class of Water Heater Consumer	Number of Consumers	Average Monthly Kwh Water Heater	Average Monthly Kwh Total for All Uses	Percent of Total Kwh Used by Heater
Farm water heaters with no supplemental heating	166	233	510	45.7
Farm water heaters with supplemental heating	68	156	450	34.7
Non-farm domestic water heaters with no supplemental heating	42	198	411	48.2
Non-farm domestic water heaters with supplemental heating	24	125	340	36.8
All water heaters in use during 1947	300	203	469	43.3
Farm water heaters with no supplemental heating connected an average of 10.48 months.	130	223	445	50.1
Non-farm domestic water heaters with no supplemental heating connected an average of 9.03 months	65	204	383	54.3
All water heaters	495	208	454	45.8

The average energy consumption for farm water heaters, with no supplemental heating, during 1947 was 237 kwh during each of the winter months, and 229 kwh during each of the summer months as compared with an average for each of the 12 months of 233 kwh.

Analyses of the various classes of water heaters, using less than 250 kwh per month, showed that they were distributed as follows:

1. Farm heaters with no supplemental heating for the year 1947 — 64.3%
2. Farm heaters with no supplemental heating in use an average of 10.48 months — 65.6%
3. Non-farm domestic heaters with no supplemental heating for 1947 — 82.5%
4. Non-farm domestic heaters with no supplemental heating in use an average of 9.03 months — 71.4%
5. All heaters with and without supplemental heating — 72.6%

Chart No. 5 shows the percentage grouping of water heater consumers according to the range of average monthly energy consumption for 1947.

b. Size of Heaters

A tabulation of the water heaters by capacities indicated a preponderance of the 30 gallon size as shown in TABLE II.

TABLE II

DISTRIBUTION OF WATER HEATERS BY CAPACITIES

Capacity in Gallons	Farm		Non-Farm		All	
	Number	Percent	Number	Percent	Number	Percent
20 (or less)	4	1.1	3	2.4	7	1.4
30	210	57.3	72	58.0	282	57.7
40	50	13.7	29	23.4	79	16.1
50	90	24.6	19	15.4	109	22.2
60	8	2.2	1	0.8	9	1.8
Over 60	4	1.1	0	0.0	4	0.8
	366	100.0	124	100.0	490	100.0

Of the 490 water heaters -

59.1% were 30 gallons or less in size
75.2% were 40 gallons or less in size

Charts No. 6 and No. 7 show the percentage distribution of sizes of water heaters in gallons for farm and non-farm domestic consumers respectively. By a comparison of the data for the two classes of consumers it may be seen that a greater percentage of the larger capacity water heaters were used by farmers than by non-farm domestic consumers.

c. Degree of Saturation of Water Heaters

The wide acceptance of electric water heaters on this system was relatively recent. Over 50 percent of those in operation during September 1948 were installed during the preceding 24 months. TABLE III shows a year to year comparison of the number of water heaters installed and their average energy consumption for September from 1941 through 1948. These data are depicted graphically by Chart No. 9.

d. Effect of Water Heater Size, Number of Persons and Use Habits on Energy Consumption

Of the 490 consumers questioned nine indicated an inadequate supply of hot water. Two of these had 40 gallon and seven had 30 gallon heaters. In eight of the nine cases an inadequate hot water supply resulted only when automatic washers were used.

TABLE III

YEAR TO YEAR COMPARISON FOR THE MONTH OF SEPTEMBER OF THE NUMBER OF WATER HEATERS INSTALLED AND THE AVERAGE ENERGY CONSUMPTION

Year	Number of Water Heaters	Average Kwh Consumption
1941	193	184
1942	239	196
1943	245	197
1944	254	185
1945	285	211
1946	351	212
1947	527	197
1948	741	200

The size of the electric water heater does not appear to make any material difference as to the amount of hot water used by the consumer. See Table IV. Examination of these data shows that the average number of kwh consumed per person per month for 30, 40, and 50 gallon heaters is practically the same after the stand-by losses have been deducted.

TABLE IV

THE AVERAGE MONTHLY COMPARISON OF ENERGY CONSUMPTION PER PERSON FOR 1947 BY GROUPING FARM WATER HEATERS ACCORDING TO SIZES

	Farm Water Heaters without Supplemental Heating			Farm Water Heaters with Supplemental Heating		
Size of heaters in gallons	30	40	50	30	40	50
Number of heaters	83	19	33	55	9	14
Average persons per heater	3.3	3.2	4.2	3.3	4.1	3.9
Average monthly kwh	210	227	269	137	182	191
Est. monthly stand-by losses	35	48	59	26*	36*	45*
Average kwh per person	64	71	64	42	44	49
Average kwh per person less stand-by losses	53	56	50	34	36	37

*Heaters using supplemental heat were considered in full operation 75 percent of the time.

An analysis of the monthly energy consumption of farm water heaters grouped according to capacity for various sizes of families further substantiates this statement. This analysis is shown graphically by Chart No. 10. The principal difference in consumption between different heater sizes with like number of persons in the family lies almost entirely in the difference in stand-by losses for the heaters considered.

These data bring to mind guides which are being used for estimating the electric water heater requirements for families of various sizes. A tabulation of two such estimating guides of manufacturers of electric water heaters is shown in TABLE V:

TABLE V

MANUFACTURERS' GUIDES OF ESTIMATES OF ELECTRIC WATER HEATER REQUIREMENTS FOR VARIOUS SIZES OF FAMILIES BASED ON 17 TO 24 HOUR CHARGING TIME

Manufacturers	Size of Family	Gallons of Hot Water per Month	Size of Water Heater in Gallons	Kwh per Month
1	2	720	30	180
2	2	850	32	210
1	3	960	40	240
2	3	1090	32	270
1	4	1200	52	300
2	4	1400	40	350
1	5	1440	52	360
2	5	1680	52	420
1	6	1680	66	420
2	6	2000	52	500
1	7	1920	82	480
2	7	2350	64	585
1	8	2160	82	540
2	8	2550	80	635
1	9	2400	2-52	600
2	9	2900	80	725

As may be noted in TABLE V there are wide differences between the recommendations of the two manufacturers as to the gallons of hot water required, size of water heater needed, and expected monthly energy consumption for various

numbers of persons served. It is doubted that these variations are due to differences in operating efficiencies of the water heaters of the respective manufacturers.

Reference is again made to Chart No. 10 where the mean of the estimated monthly kwh requirements for various numbers of persons, as set forth in the manufacturers guide, has been plotted in comparison with the actual monthly kwh usage as found in this investigation. It is pointed out that as the number of persons increases, the discrepancy in kwh increases at a rapid rate.

The size of water heater has a material effect on the monthly energy consumption regardless of the family size or their use habits. As shown by Chart No. 11 the larger the water heater the greater the stand-by losses in kwh per day. This also is reflected in the average monthly energy requirement of any electric hot water system.

An analysis of the effect of bath facilities on the energy consumption of electric water heaters of farm consumers for 1947 is shown by TABLE VI.

TABLE VI

EFFECT OF BATH FACILITIES AND SIZE OF FAMILY ON THE ENERGY CONSUMPTION OF FARM WATER HEATERS FOR THE YEAR 1947

	Type of Bath Facilities					
	Tub			Shower or combination		
Size of heater	30	40	50	30	40	50
Number of consumers	37	4	9	32	19	19
Number of persons	3.4	3.3	4.1	3.1	3.3	4.4
Average monthly kwh	186	245	234	219	254	292
Kwh per person per month	55	74	57	71	77	66

The data in TABLE VI indicate that consumers having bath tubs used less energy per person than did those having a shower or a combination shower and tub bath. The latter either used more hot water in bathing or took a greater number of baths because of the convenience that a shower offers for such purposes.

A tabular analysis was made to determine the effect of the type of farm on the monthly energy consumption of farm water heaters. However, due to the limited number of farms in the various categories for the different sizes of heaters no definite conclusions could be reached. Indications were that livestock and poultry farms were the highest consumers, with dairy farms third and general farms last. However, more than 50 percent of the dairy farms had separate dairy water heaters whose energy consumption was not considered. If such had not been the case the dairy farms would have been the highest consumers. The data reflected the fact that livestock, poultry, and dairy farms used considerably more hot water in connection with the farming enterprise than did general farms.

e. Effects of Supplemental Heating and Higher Water Temperatures

Supplemental water heating was used in conjunction with electric water heaters by 28.8 percent of the farm consumers and 37.6 percent of the non-farm domestic consumers. The annual energy consumption of the water heaters of those who followed this practice was reduced by 970 kwh, or 30 percent, of the average of those not employing it.

When electric water heating is supplemented by furnace coils or other means of water heating during the winter months, the kw demand per heater may be reduced materially. Tests were conducted in 1947 by Technical Standards Division, REA, on the distribution systems of the Oakdale Cooperative Electric Association, Oakdale, Wisconsin and the Steuben County Rural Electric Membership Corporation, Angola, Indiana. The results of these tests are set forth in Technical Standards report, dated June 1949, entitled "Off-Peak Control of Water Heaters on Rural Power Systems." These data indicated the following:

> "Water heaters contributed between 500 and 600 watts per heater to the peak demands on the two systems tested. The measured contribution per heater was 520 watts on the Oakdale system and 600 watts on the Steuben system. Water heaters on the Steuben system averaged larger in tank size and considerably larger in lower element rating than those on the Oakdale system. This difference in heater characteristics did not appear to influence the average measured load per heater during peak load periods. The load per heater seems to be more closely related to the kilowatt-hours used in heating water than to either the element or the tank size."

By the use of these test data, it is estimated that supplemental water heating reduces the peak kw demand per heater by about 60 percent. This would prove advantageous to the power supplier as far as kw demand during peak is concerned if no off-peak control equipment is in use. A graphical comparison of the monthly diversified peak kw demand for farm water heaters with and without supplemental heating for the year 1947 is shown by Chart No. 8.

Most consumers were of the opinion that the use of furnace coils as a means of supplementing electric water heating presented an economic advantage. They were unfamiliar with the possible harmful effects to the hot water system. During periods of extremely cold weather when the house-heating furnace is operating at near maximum capacity, it is quite possible for the water-heating furnace coil to deliver water at a temperature as high as 200° F. Such water temperatures in the hot water system can have a serious effect on the efficiency and life of the system. The following is quoted from:

Engineering Bulletin Volume XXIV, No. 3a, "Scale Formation in Water Heaters and Methods of Prevention" by J. M. Krappe, published in 1940 by Engineering Experiment Station, Purdue University, Lafayette, Indiana.

"DOMESTIC HEATER TESTS - EFFECT OF TEMPERATURES"

"The results of these tests were comparative for the different temperatures and gave a definite indication that the rate of scale formation increased quite rapidly with the temperature maintained. A very rapid increase in the rate of scale formation as shown graphically by (Chart No. 12) was obtained between 140 degrees and 180 degrees F. In fact, the rate of scale formation at the higher temperature was seven times as great as that at normal domestic service temperatures.

"From the test results the time that this heater may be in service before the scale deposit interferes with the operation of the heater may be estimated as follows:

With the thermostat set for an outlet temperature of 120° - 12 years.
With the thermostat set for an outlet temperature of 140° - 7 years.
With the thermostat set for an outlet temperature of 180° - 2 years.

"These statements are based on the accelerated scaling tests using a water supply having a hardness of 20 grains equivalent calcium carbonate per U. S. gallon. They are also based on the average usage of 50 gallons of 140° F water per day or its thermal equivalent for other temperatures.

"At a temperature of 180° F, scale deposits will obstruct outlet pipes from the heater before enough material has formed in the heater to interfere with its operation."

The report states further that in classifying the various types of water heaters that furnace coils rank first in their tendency to give service difficulty from scale formation.

Gas water heaters were used in the study referred to previously. The results obtained are considered applicable to electric water heaters, as the water temperature presents the major problem and not the source of the heat. Hence it is apparent that the employment of furnace coils as a means of supplementing electric water heating is a poor practice which results in a reduction of the efficiency and the life of the hot water system. The fact that additional fuel must be burned in the furnace if heating of water is to be accomplished is also overlooked by most people. It seems clear that a complete cost analysis of this practice would prove this method to be uneconomical

High water temperatures not only increase the scale formation but also increase the stand-by losses, both in the water heater and in the hot water

distribution system. Thus the energy requirements of the water heater are increased. The effects on the stand-by losses of electric water heaters are depicted graphically by Chart No. 11. Care must be exercised in recommendations to owners as to the setting of thermostats at higher temperatures to provide hotter water for the purpose of washing or other special requirements. It was noted in the visits to consumers that where such recommendations were followed the consumer did not take the trouble to reset the thermostat to lower temperatures. The consumers complained of high monthly bills, and were unknowingly reducing the life of their electric hot water systems.

f. Other Findings

The consumers were well satisfied with electric water heater service. Separate metering of electric water heaters emphasizes to the consumer that part of the electric bill which applies to the cost of a hot water supply. The resulting effect is that many consumers feel that the cost is too high. It is important that individual costs of various electrical applications comprising the consumer's bill be explained prior to the initiation of separate metering.

Several water heaters were installed in such a manner that a circulating hot water system existed. The consumer was aware only of the fact that he had unusually high water heater electric bills.

Some range boilers, which had been converted to electric hot water heaters with insert units, had no insulation around the tank. These consumers complained of high bills.

Lower elements of some water heaters had been burned out by lightning surges during electrical storms. Consumers did not know these units were not operating.

CONCLUSIONS

The results of this investigation, although not conclusive in all matters, do accentuate certain factors which at present are not given proper consideration. It is apparent that many recommendations regarding the use of water heaters are not always of a beneficial nature to the consumer. Temperatures above 150° F should not be recommended in most areas unless water softening equipment is used in conjunction with the hot water system. It is not likely in most cases that a consumer who sets the controlling thermostat to supply hotter water for a repetitive job will return it to the recommended normal setting. If thermostats are set so that heaters will deliver water at temperatures above 150° F the life of the water heater and the hot water system may be considerably reduced.

There is considerable need for the dissemination of information as to the harmful effects of using furnace coils for supplementing electric water heating. The need for assisting consumers in making cost analyses of the installation and operation of hot water systems should also be emphasized.

The use of automatic washing machines requires considerable quantities of hot water within relatively short periods of time if consumers desire to complete their weekly washing in a single day. In such cases it should be pointed out to consumers that larger water heaters are required to meet this special hot water demand.

A definite need exists for greater consistency in the guides published by manufacturers as to water heater requirements for various sizes of families. The wide variation between the recommendations of different manufacturers and the great differences between their recommendations and the test data are especially significant.

The adoption of large capacity water heaters, with low wattage heating elements, for use by farm consumers would not prove economical from the consumer's standpoint. Such water heaters would require a higher initial investment and the increased stand-by losses of the large heaters would result in a considerable increase in the monthly cost of electric energy for providing the consumer's hot water requirements.

This investigation indicates that on some farms water heaters of less than 50 gallon capacity may be satisfactory. This represents a change from observations previously made. However, since a majority of the consumers on this system had heaters of less than 50 gallons in size and reported a satisfactory supply of hot water except where automatic washing machines were used, this conclusion seems justified. Disregarding stand-by losses, energy consumption was approximately 50 kwh per person per month regardless of heater size. For a family of 4 persons or less where the use of automatic washers or similar equipment is not contemplated, a 30 or 40 gallon heater seems ample for household use unless the family plans extraordinary use of hot water. Where automatic washing equipment is to be used or in cases where the number of persons in the family will be greater than 4, larger water heaters should be used.

The quantity of hot water used by the consumer does not appear to be affected by the size of water heater installed on the consumer's premises.

There are many considerations which should be weighed by REA borrowers prior to the installation of control equipment on the electric water heaters of their distribution systems. The installation of such equipment if wrongly applied may require the members to purchase larger sizes of water heaters with the result that the initial investment as well as the cost of operation may be increased. Since the consumer is the member-owner of the rural

electric cooperative, any additional expenditure whether by the cooperative or the member results in an expense to the member. A complete analysis should be made by each individual rural electric system to determine the advantages and/or disadvantages to the member and the cooperative before such equipment is installed. An approach to this analysis may be obtained from Appendix I, REA Publication, "Off-Peak Control of Water Heaters on Rural Power Systems." The following questions should be answered by such an analysis:

1. What will be the cost of the water heater control equipment for each installation?

2. Is the control equipment to be operated in such a manner as to require members to purchase larger water heaters to insure themselves an adequate supply of hot water?

3. If the answer to question 2 is yes, what is the total additional cost to the member because of higher investment in a larger size of water heater and higher monthly operating cost because of greater stand-by losses?

4. If the total expense to the member and the cooperative is combined, is any real saving realized by the cooperative or the members?

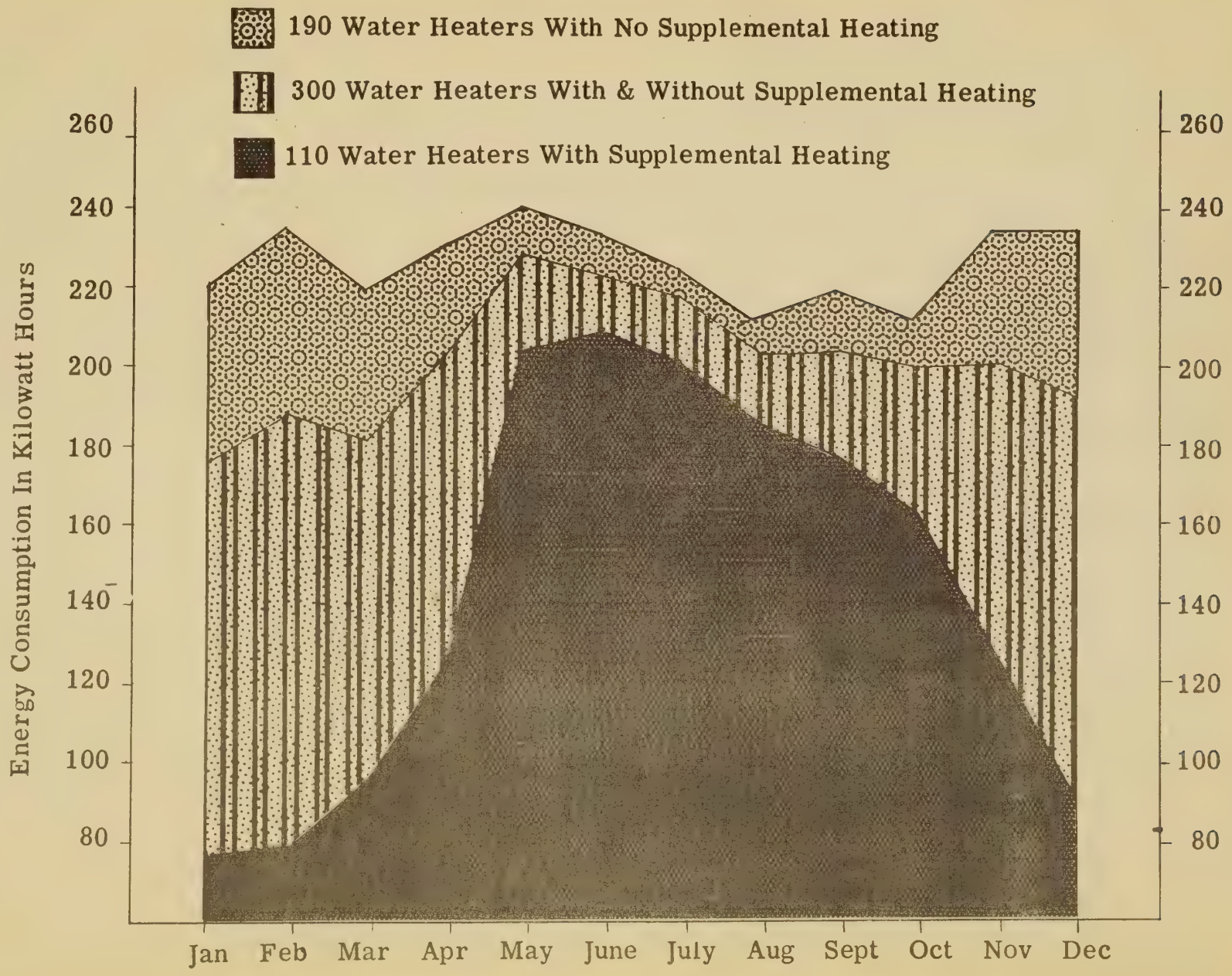
5. Is the installation of controls being considered because the distribution system will not provide satisfactory service unless the peak demand of the system is reduced, or is the primary interest to reduce the cost of wholesale electrical energy?

6. If the controls are necessary to provide satisfactory service will this solve the problem for a long enough period of time to amortize the investment in the control equipment?

Chart #1

AVERAGE MONTHLY ENERGY CONSUMPTION OF ALL WATER HEATERS FOR THE YEAR 1947

Ohio Midland Light & Power Co.
Canal Winchester, Ohio



AVERAGE MONTHLY ENERGY CONSUMPTION OF FARM WATER HEATERS FOR THE YEAR 1947

Ohio Midland Light & Power Co.
Canal Winchester, Ohio

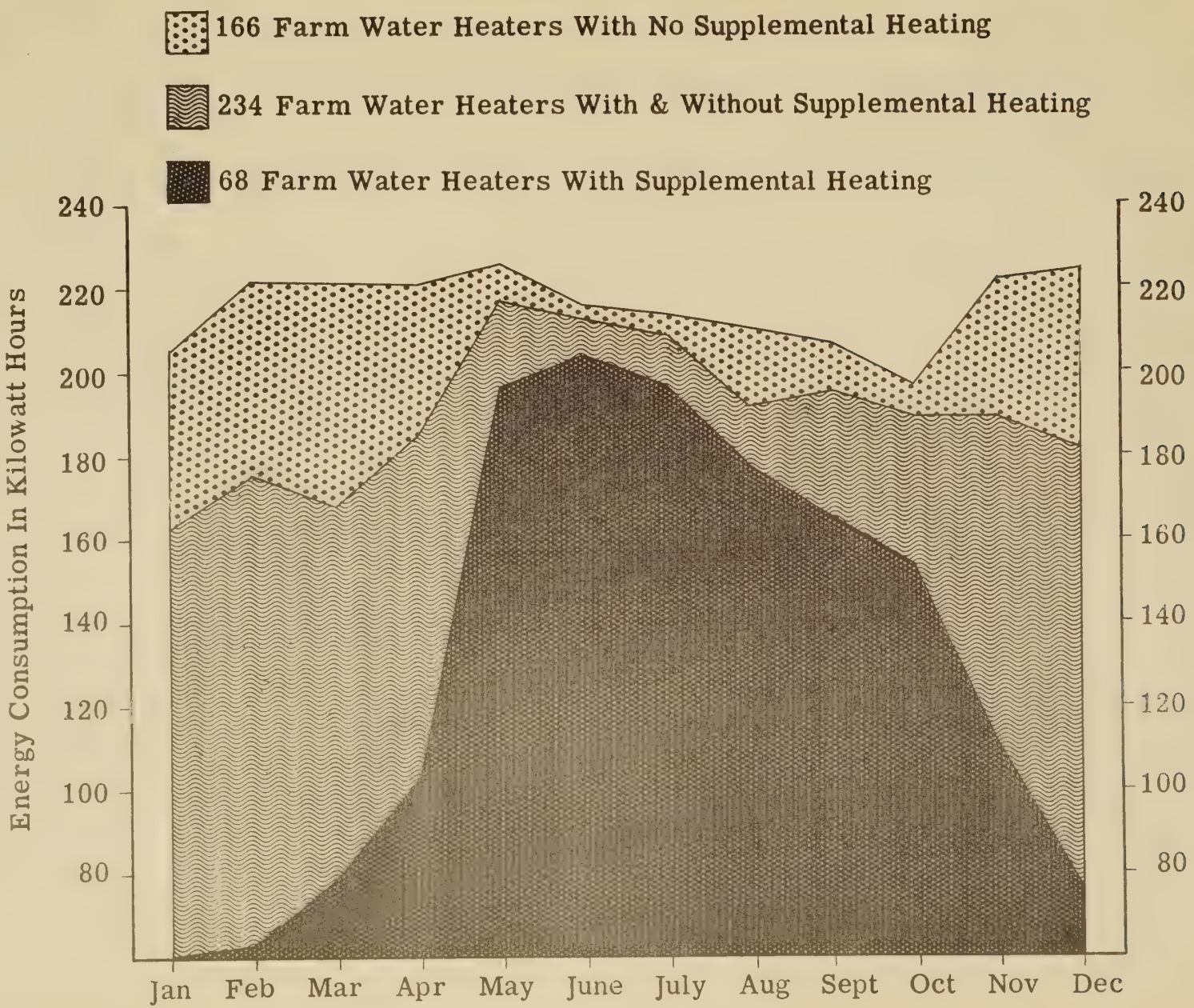


Chart #2

AVERAGE MONTHLY ENERGY CONSUMPTION OF NON-FARM DOMESTIC WATER HEATERS FOR THE YEAR 1947

Ohio Midland Light & Power Co
Canal Winchester, Ohio

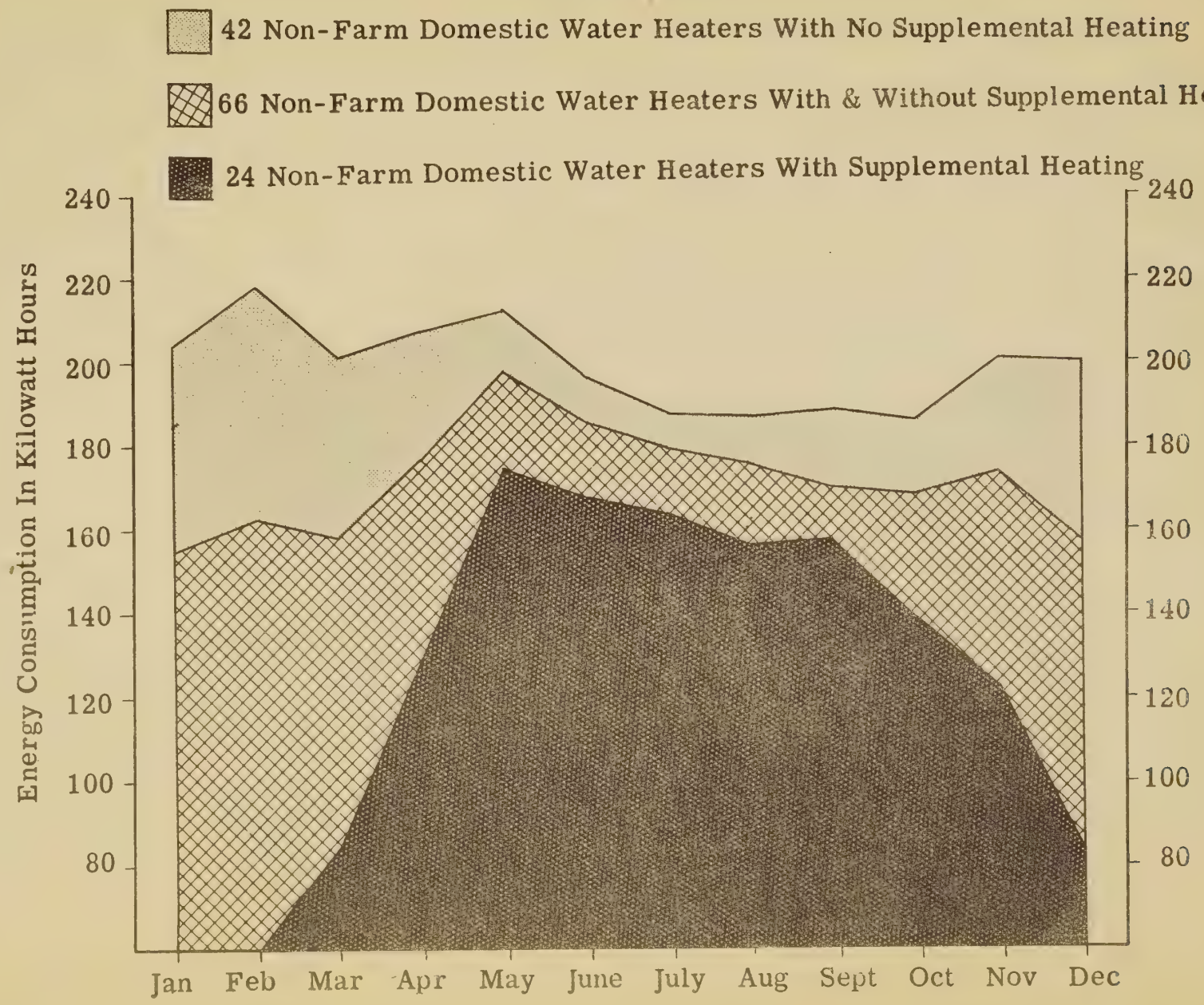
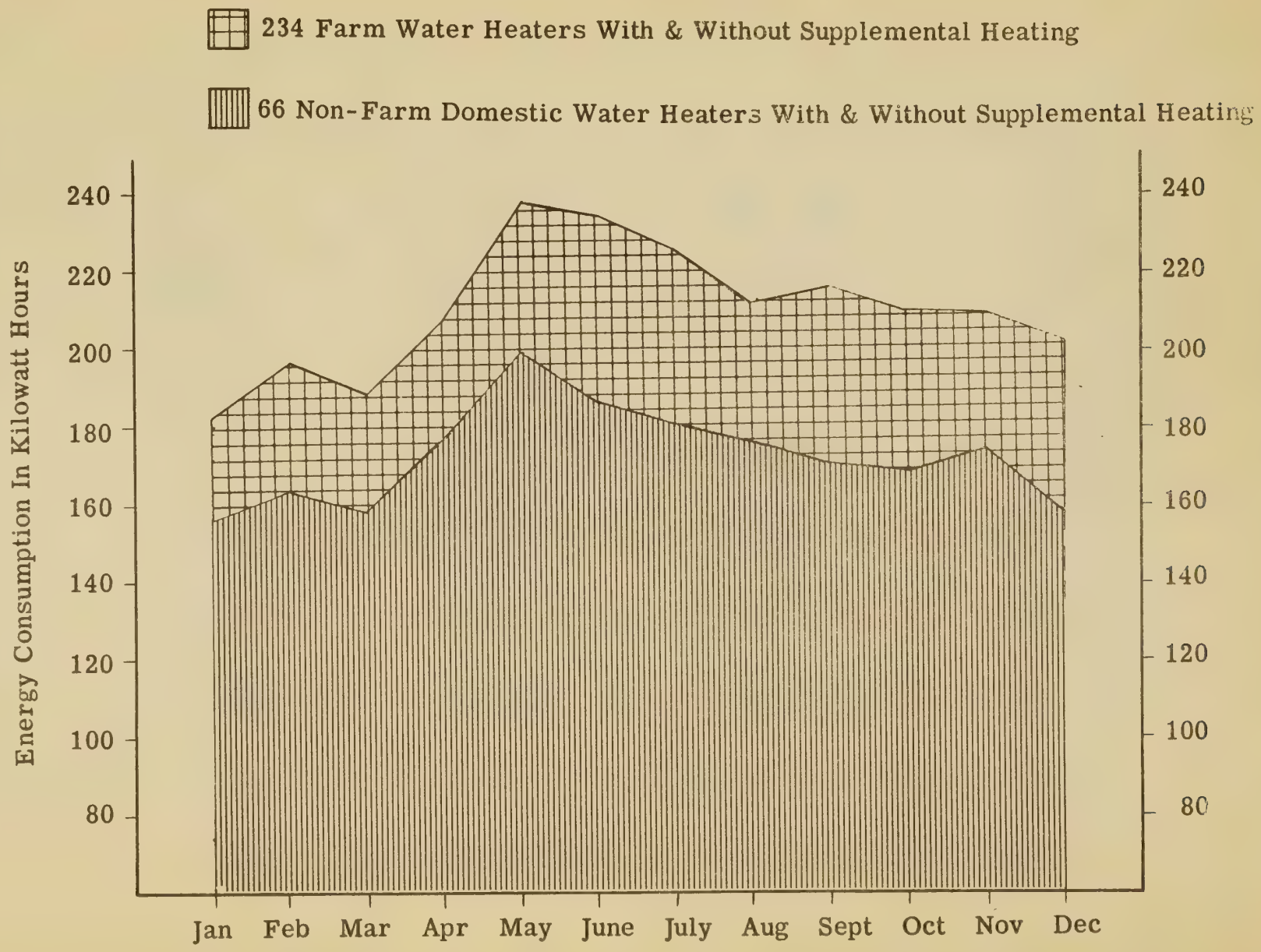


Chart #3

Chart #4

COMPARISON OF AVERAGE MONTHLY ENERGY CONSUMPTION OF ALL WATER HEATERS OF FARM AND NON-FARM DOMESTIC CONSUMERS FOR THE YEAR 1947

Ohio Midland Light & Power Co.
Canal Winchester, Ohio



PERCENTAGE GROUPING OF WATER HEATER CONSUMERS ACCORDING TO RANGE OF AVERAGE MONTHLY ENERGY CONSUMPTION FOR THE YEAR 1947

Ohio Midland Light & Power Co.
Canal Winchester, Ohio

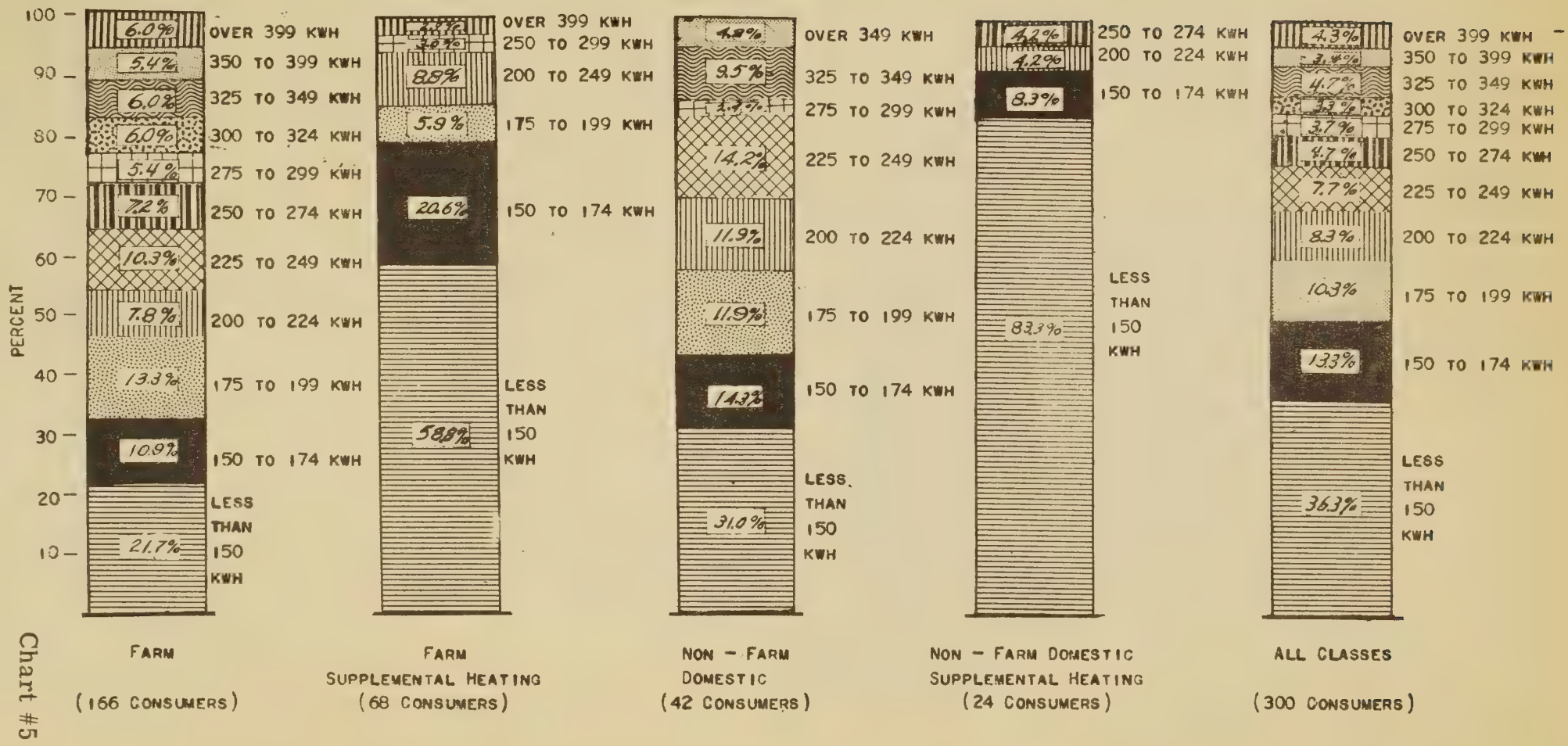


Chart #5

PERCENTAGE DISTRIBUTION OF SIZES OF WATER HEATERS FOR 366 FARM CONSUMERS
Ohio Midland Light & Power Co.
Canal Winchester, Ohio

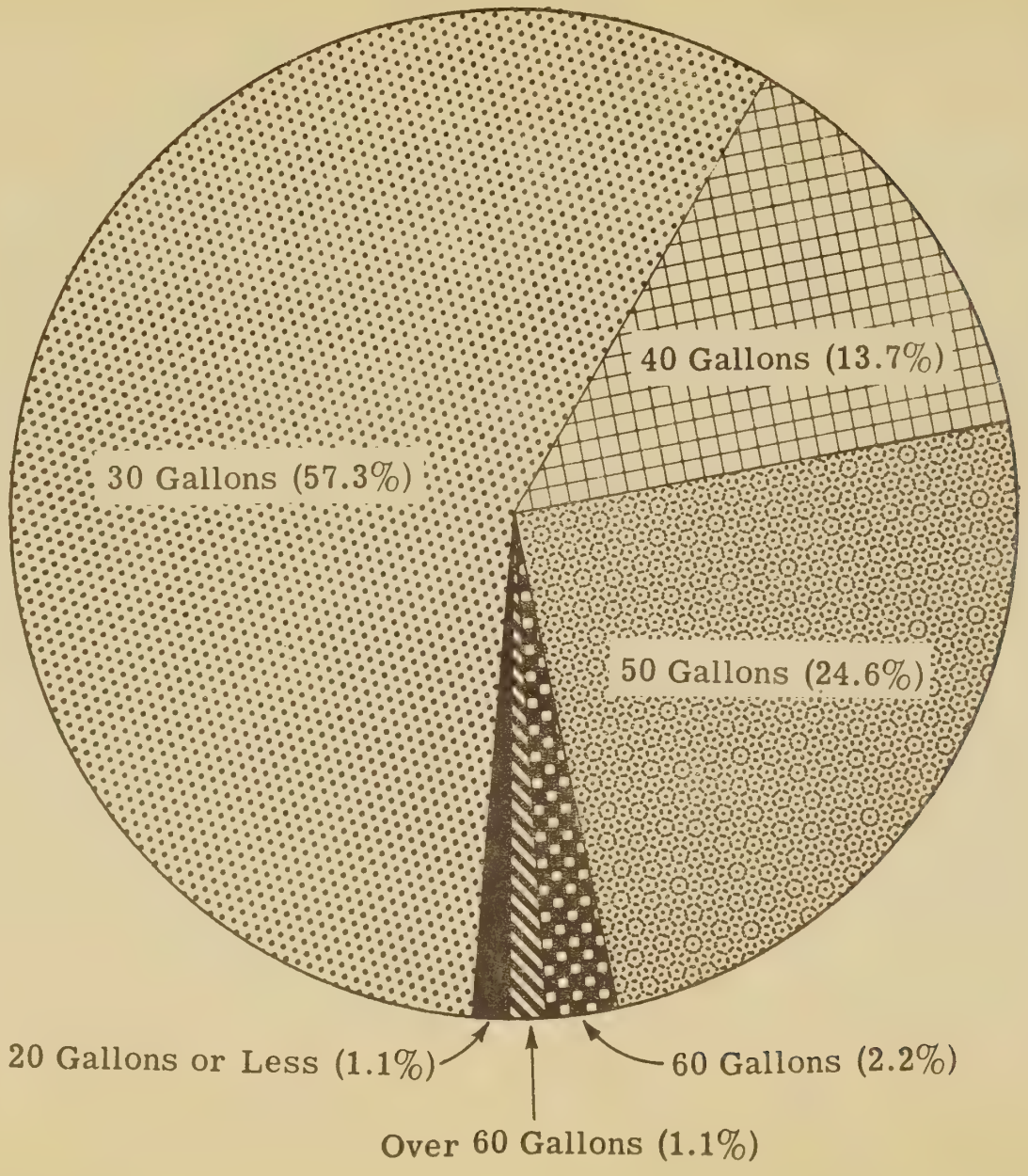


Chart #6

PERCENTAGE DISTRIBUTION OF SIZES OF WATER HEATERS FOR 124 NON-FARM DOMESTIC CONSUMERS
Ohio Midland Light & Power Co.
Canal Winchester, Ohio

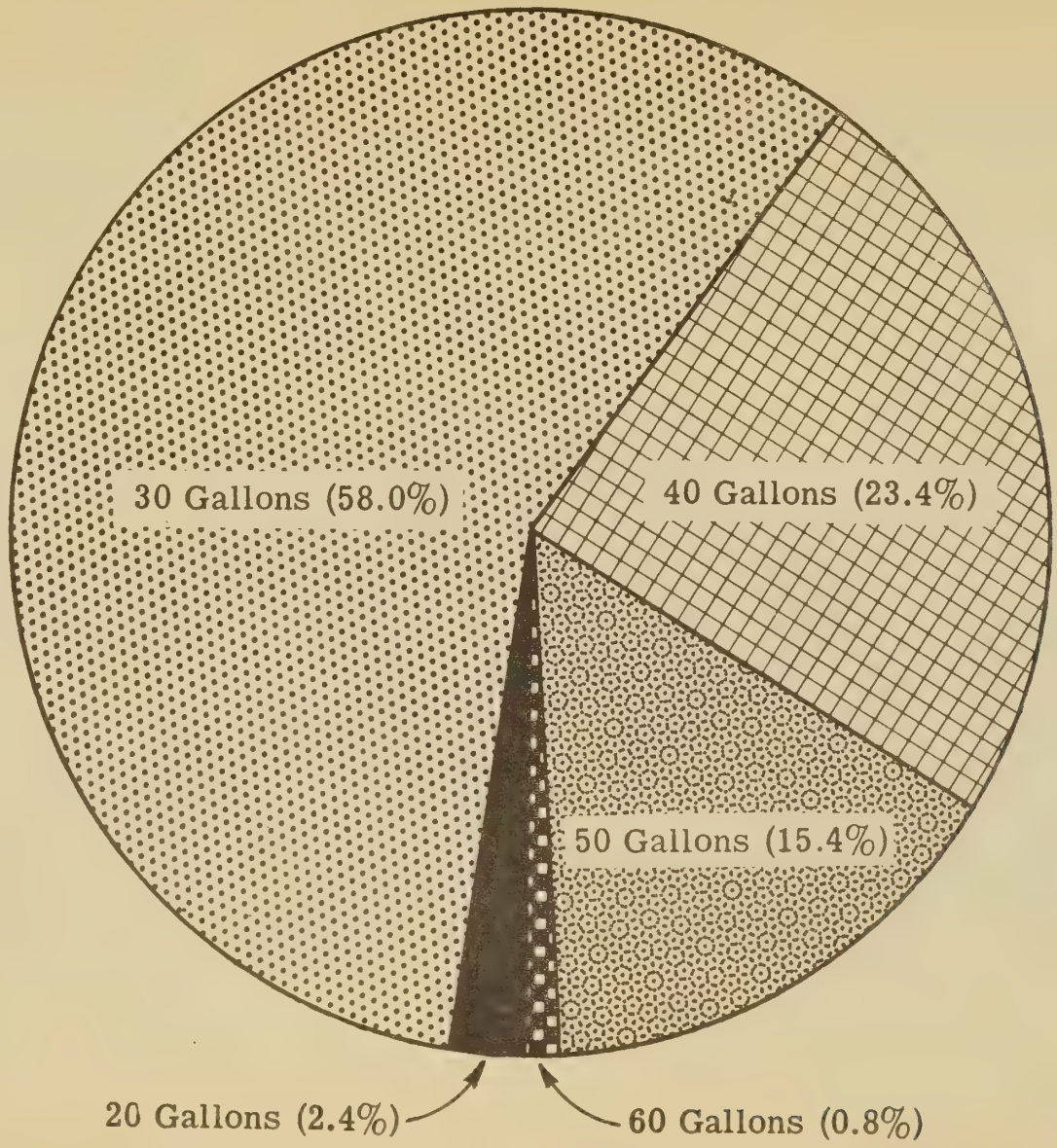
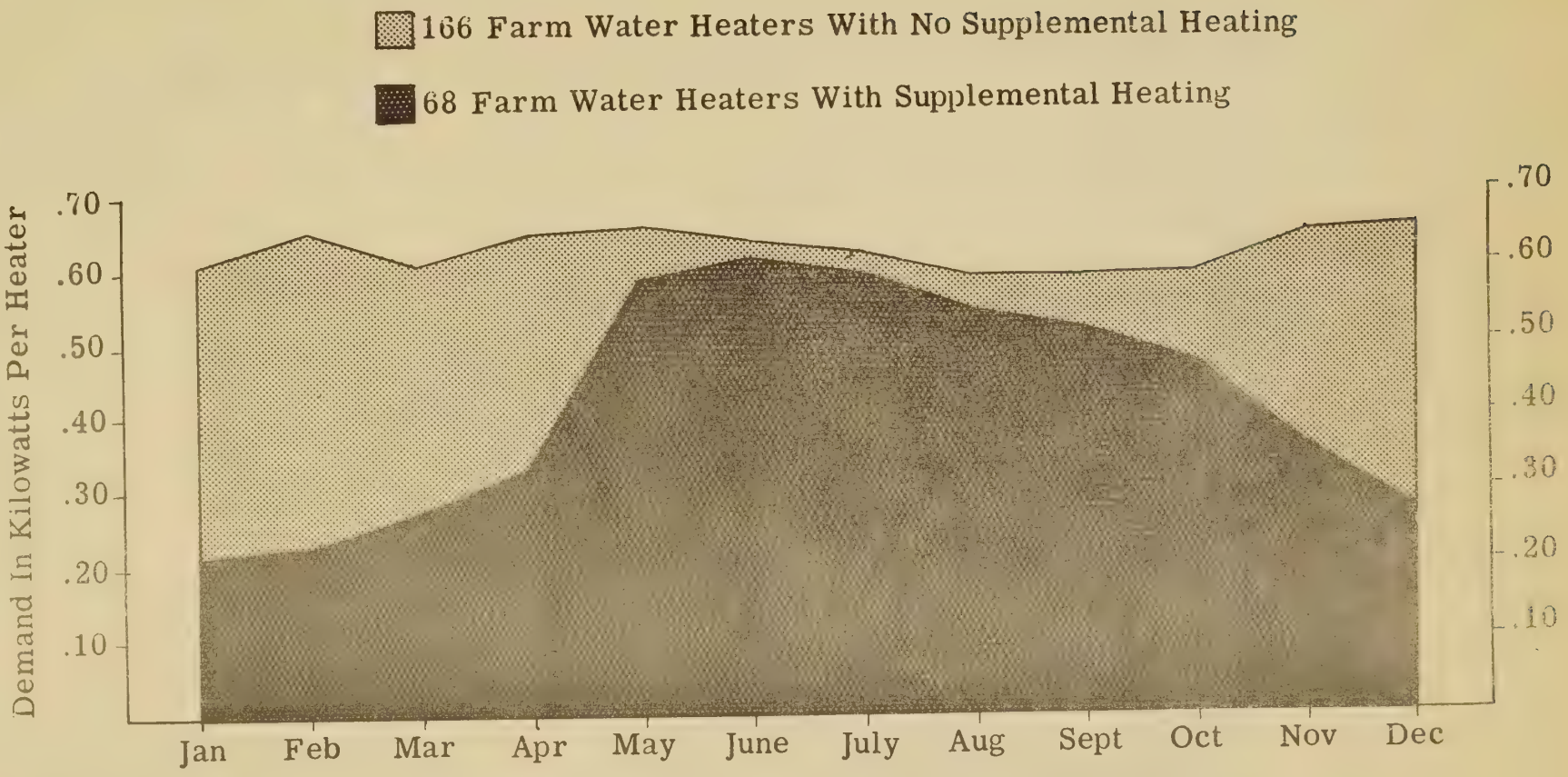


Chart #7

Chart #8

ESTIMATED MONTHLY DIVERSIFIED PEAK KILOWATT DEMAND OF FARM WATER HEATERS FOR THE YEAR 1947

Ohio Midland Light & Power Co.
Canal Winchester, Ohio



YEAR TO YEAR COMPARISON OF NUMBER OF WATER HEATERS AND MONTHLY ENERGY CONSUMPTION

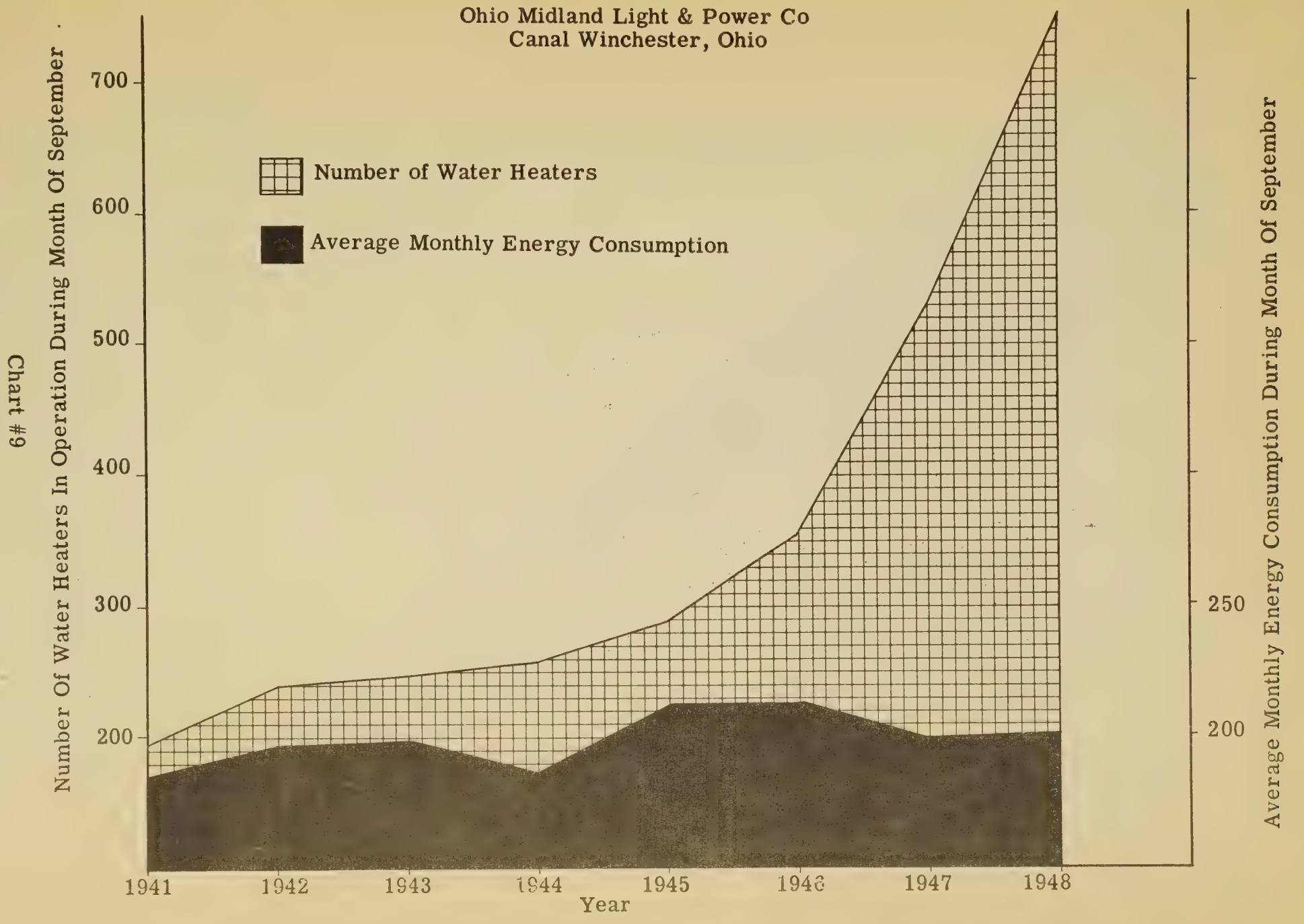


Chart #9

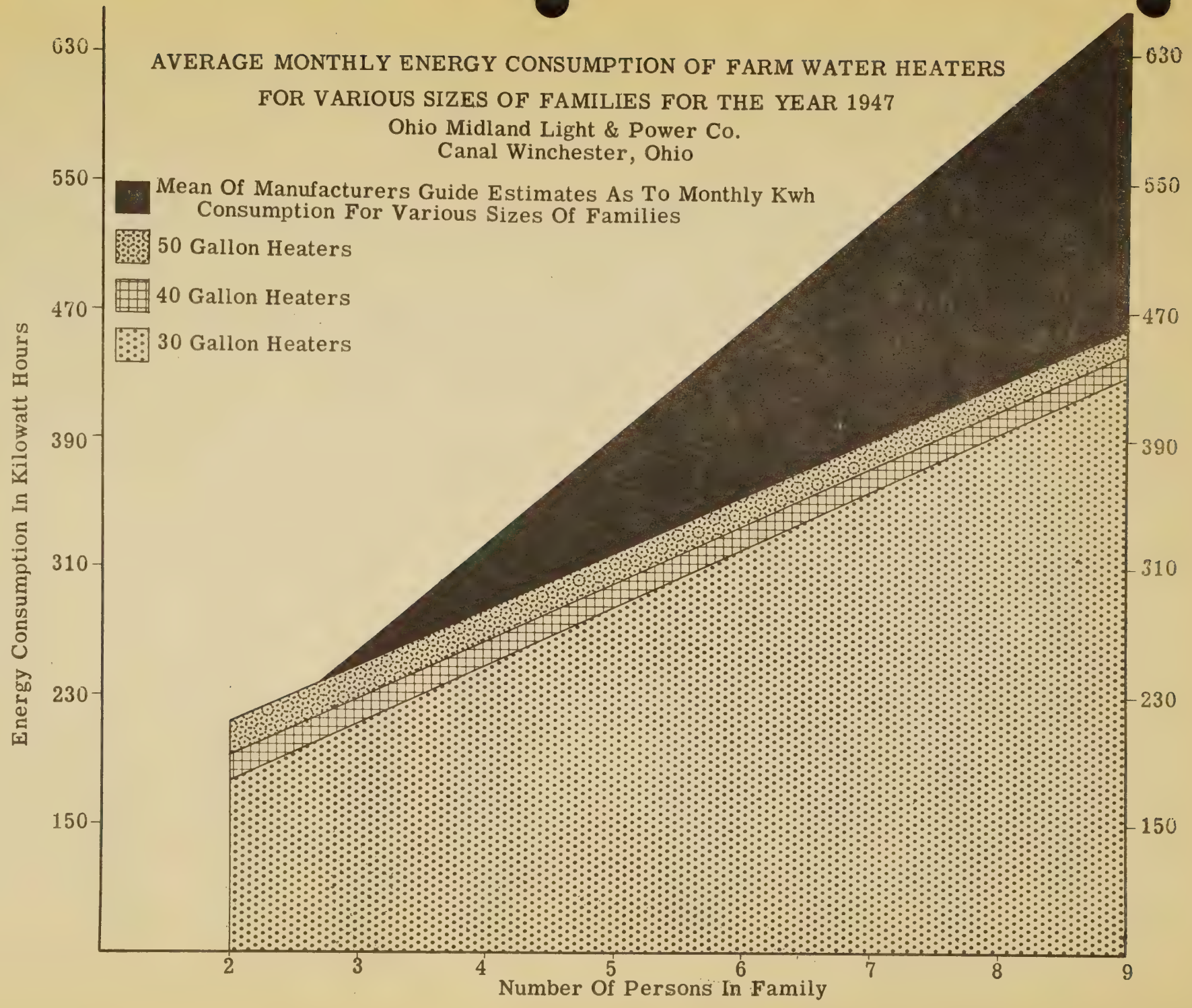

AVERAGE MONTHLY ENERGY CONSUMPTION OF FARM WATER HEATERS
FOR VARIOUS SIZES OF FAMILIES FOR THE YEAR 1947
Ohio Midland Light & Power Co.
Canal Winchester, Ohio
Mean Of Manufacturers Guide Estimates As To Monthly Kwh Consumption For Various Sizes Of Families
50 Gallon Heaters
40 Gallon Heaters
30 Gallon Heaters
Energy Consumption In Kilowatt Hours
630
550
470
390
310
230
150
2
3
4
5
6
7
8
9
Number Of Persons In Family

Chart #10

EFFECT OF WATER TEMPERATURE AND AMBIENT TEMPERATURE ON STAND-BY LOSSES OF VARIOUS SIZES OF ELECTRIC WATER HEATERS

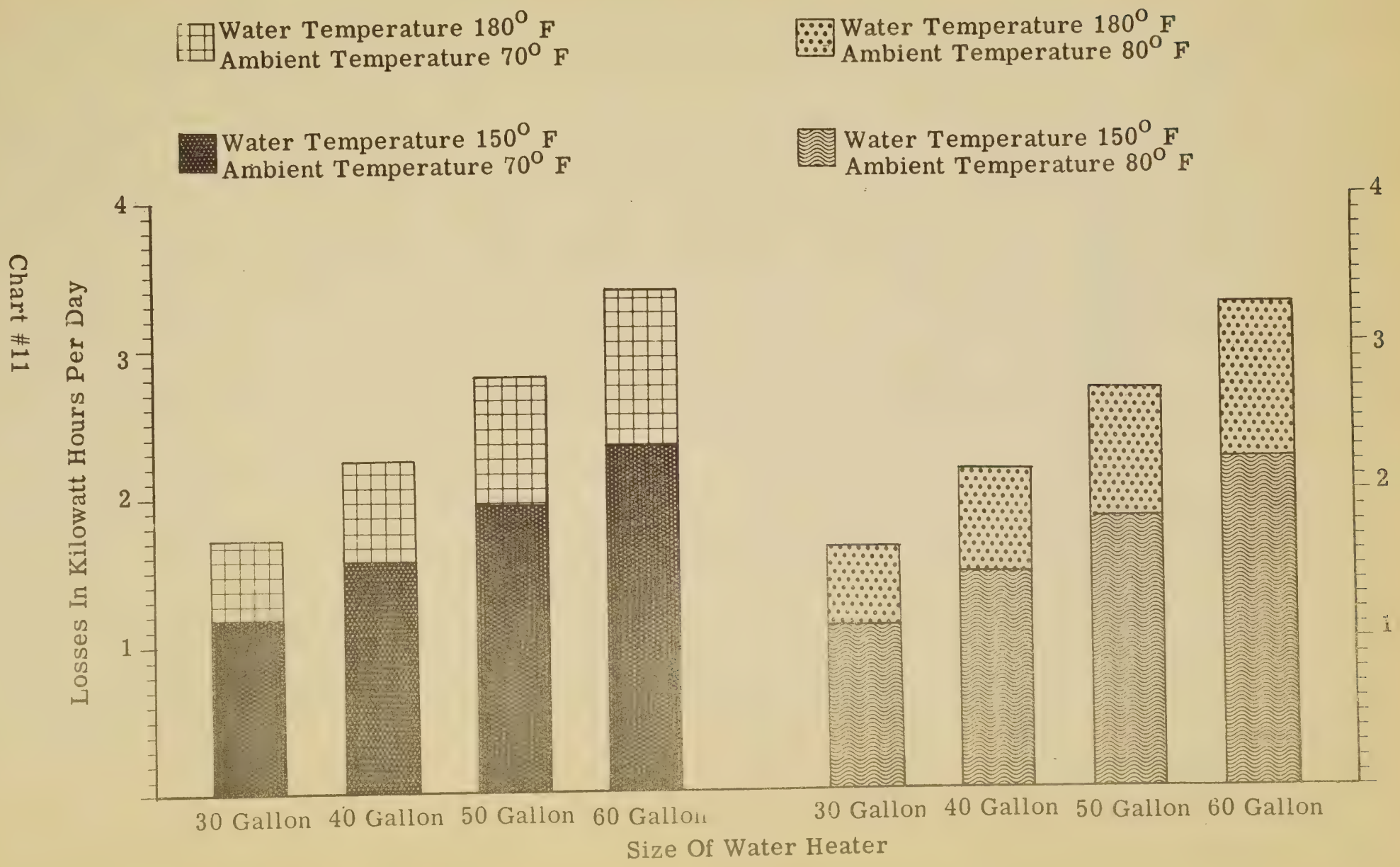
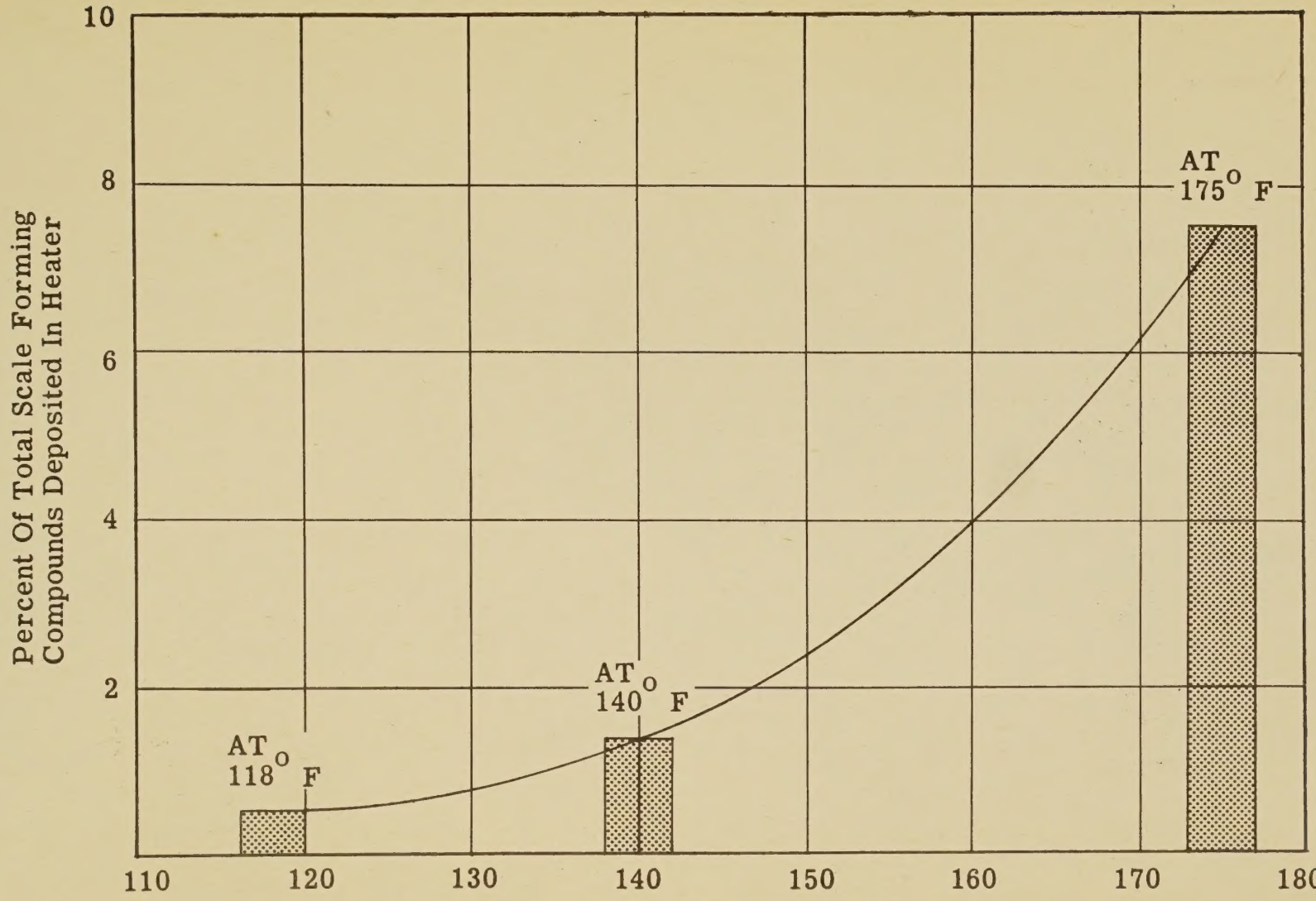


Chart #11

Chart #12

EFFECT OF TEMPERATURE ON SCALE FORMATION



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